# RENEWABLE ENERGY

**An International Journal** 

Incorporating

**Solar and Wind Technology** 



Volume 2, Contents and Author Index, 1992



Oxford · New York · Seoul · Tokyo

# RENEWABLE ENERGY

Sponsors: UNESCO, The International Centre for Theoretical Physics, Trieste, Italy

# Editor-in-Chief

Professor A. A. M. Sayigh, Energy Group, Department of Engineering, The University of Reading, Whiteknights, Reading RG6 2AY, U.K.

# Editorial Advisory Board

A.-E.-H. Adane, Algiers, Algeria

S. Al-Azzawi, Dartford, U.K.

N. I. Al-Hamdani, Baghdad, Iraq

S. Ayyash, Kuwait

J. Bahraoui-Buret, Rabat, Morocco

L. Broman, Borlange, Sweden

I. Chambouleyron, Campanis, Brazil

B. R. Clayton, Nottingham, U.K.

L. J. Duckers, Coventry, U.K.

P. D. Dunn, Reading, U.K.

R. H. B. Exell, Bangkok, Thailand

D. Fulford, Reading, U.K.

H. P. Garg, New Delhi, India

A. Goetzburger, Freiburg, Germany

C. G. Granqvist, Goteborg, Sweden

M. G. Hutchins, Oxford, U.K.

P. C. Jain, Lusaka, Zambia

F. Kreith, Boulder, CO, U.S.A.

E. H. Lysen, Leusden, The

Netherlands

A. Madan, Boulder, CO, U.S.A.

F. Meunier, Orsay, France

M. A. Muntasser, Tripoli, Libya

S. S. Nandwani, Heredia, Costa Rica

D. Nobili, Bologne, Italy

B. Norton, Belfast, Northern Ireland

M. B. Prince, Washington, U.S.A.

F. S. Stoddard, Canyon, TX, U.S.A.

J. Twidell, Glasgow, U.K.

K. Watanabe, Tokyo, Japan

# Production Editor

Catherine Morgan, Pergamon Press Ltd, Oxford OX3 0BW, U.K. Tel. 0865 743741.

#### **Publishing, Subscription and Advertising Offices**

Subscription enquiries from customers in North America should be sent to: Pergamon Press Inc., 660 White Plains Road, Tarrytown, NY 10591–5153, U.S.A., and for the remainder of the world to: Pergamon Press Ltd, Headington Hill Hall, Oxford OX3 0BW, U.K.

#### **Subscription Rates**

Annual Institutional Subscription Rate (1993): £295.00 (U.S. \$561.00). Personal subscription rate for those whose library subscribes at the regular rate is available on request. Sterling prices are definitive. U.S. dollar prices are quoted for convenience only, and are subject to exchange rate fluctuation. Prices include postage and insurance and are subject to change without notice. Subscription rates for Japan are available on request.

Published six issues per annum in February, April, June, August, October and December

## Copyright © 1993 Pergamon Press Ltd

Whilst every effort is made by the publishers and editorial board to see that no inaccurate or misleading data, opinion or statement appear in this journal, they wish to make it clear that the data and opinions appearing in the articles and advertisements herein are the sole responsibility of the contributor or advertiser concerned. Accordingly, the publishers, the editorial board and editors and their respective employees, officers and agents accept no responsibility or liability whatsoever for the consequences of any such inaccurate or misleading data, opinion or statement.

Application to mail at second class postage rate is pending at Rahway, NJ. Postmaster send address corrections to *Renewable Energy*, c/o Pergamon Press Inc., 660 White Plains Road, Tarrytown, NY 10591–5153, U.S.A.

# CONTENTS

## NUMBER 1

Articles Ji Qin Ni and Hang Zhou	1	Energy consumption and conservation in tea processing in China
A. Boubakri, M. Arsalane, B. Yous, L. Ali-Moussa, M. Pons, F. Meunier and J. J. Guilleminot	7	Experimental study of adsorptive solar-powered ice makers in Agadir (Morocco)—1. Performance in actual site
A. Boubakri, M. Arsalane, B. Yous, L. Ali-Moussa, M. Pons, F. Meunier and J. J. Guilleminot	15	Experimental study of adsorptive solar-powered ice makers in Agadir (Morocco)—2. Influences of meteorological parameters
R. Festa, S. Jain and C. F. Ratto	23	Stochastic modelling of daily global irradiation
L. O. Adekoya and A. A. Adewale	35	Wind energy potential of Nigeria
M. A. El-Kosheiry and A. H. M. Shousha	41	On the improvement of tandem solar cell conversion efficiency
F. A. Al-Sulaiman and F. A. Jamjoum	47	Applications of wind power on the east coast of Saudi Arabia
M. Fujinaka	57	Solar cars free of environmental pollution—prototype of practically usable car completed
Data Bank N. Al Mahdi, N. S. Al Baharna and F. F. Zaki	65	Assessment of solar radiation models for the Gulf Arabian countries
Technical Notes  A. S. A. Ammar, M. A. El-Osairy and A. A. Ghoneim	73	Comparison of measured and predicted performance of heat storage unit packed with spheres of a local material
A. I. Salem, A. A. Trabea and Z. Awwad	77	Semi-empirical relationships for calculating net and net long-wave solar radiation over Egypt
A. K. Som and S. M. Al-Alawi	85	Evaluation of efficiency and degradation of mono- and polycrystalline PV modules under outdoor conditions
A. K. Som	93	Solar UV-B radiation measurement over Bahrain
WARE News	99	
Calendar of Events	101	

## NUMBER 2

Articles G. D. Skikos and A. V. Machias	103	FEC: a fuzzy based economic criterion for the evaluation of wind power investments
R. K. Mazumder and M. Hussain	111	Performance studies of two discrete mirror, seasonally-adjusted, linear solar concentrators

## Contents

S. A. Kalogirou and S. Lloyd	117	Use of solar Parabolic Trough Collectors for hot water production in Cyprus. A feasibility study
B. Rezig, H. Dahman and M. Kenzari	125	Iron pyrite FeS <sub>2</sub> for flexible solar cells
H. Loutfi and A. Khtira	129	Stochastic analysis and generation of synthetic sequences of daily global solar irradiation: Rabat site (Morocco)
X. Berger, J. Bathiebo, F. Kieno and C. N. Awanou	139	Clear sky radiation as a function of altitude
H. Schaefer and G. Hagedorn	159	Hidden energy and correlated environmental characteristics of P.V. power generation
Data Bank M. Al-Riahi, N. Al-Hamdani and H. Al-Saffar	167	Some aspects of solar radiation climatology of Iraq
P. Akhter, A. Baig and A. Mufti	175	On the measurement of clear day solar irradiance components at Islamabad
Technical Note A. K. Agarwal	181	Two axis tracking system for solar concentrators
M. A. K. Lodhi and M. Y. Sulaiman	183	Helio-aero-gravity electric power production at low cost
R. Guzzi	191	Sun irradiance and local breeze parametric approach by statistical method
Letter to the Editor M. M. Elsayed	195	Convention of solar and surface azimuth angles
WARE News	197	
Calendar of Events	199	

## NUMBER 3

Articles L. Mangialardi and G. Mantriota	201	The advantages of using continuously variable transmissions in wind power systems
H. P. Garg, C. Choudhury, R. Jha and Z. H. Zaidi	211	Performance prediction of a hybrid air-to-water solar heater
I. M. Michaelides, W. C. Lee, D. R. Wilson and P. P. Votsis	219	An investigation into the performance and cost effectiveness of thermosyphon solar water heaters
A. Chaurey and S. Deambi	227	Battery storage for PV power systems: an overview
M. M. Bajwa	237	Effectiveness of nocturnal ventilative passive cooling strategy in the maritime desert climate of the Arabian Gulf region
M. M. Bajwa	255	Direct convective passive cooling as an energy conserving technique in the maritime desert climate of the Arabian Gulf region
M. A. Hammad and M. S. Audi	275	Performance of a solar LiBr-water absorption refrigeration system
B. Norton, J. E. J. Edmonds and E. Kovolos	283	Dynamic simulation of indirect thermosyphon solar energy water heaters

Contents

M. A. Hamdan and B. A. Jubran	299	Some theoretical and experimental aspects of built-in solar storage
<i>Data Bank</i> J. Cañada	305	Solar radiation prediction from sunshine in eastern Spain
S. Amoussa	311	Estimation of global solar radiation in Benin
K. Sopian and M. Y. Hj. Othman	319	Estimates of monthly average daily global solar radiation in Malaysia
Technical Notes C. D. Rakopoulos	327	Comparative performance and emission studies when using olive oil as a fuel supplement in DI and IDI diesel engines
R. Ben Maad and A. Belghith	333	The use of grid-generated turbulence to improve heat transfer in passive solar systems
D. K. Dixit	337	A simulation model of the rectification column of a solar cold storage unit
A. Lubis and Z. Udin	343	Three and a half years field test of fluorescent lamp as a load for PV rural electrification system
A. V. Souproun	347	Short term experimental procedure for the determination of solar collectors' time constant
WARE News	349	
Calendar of Events	351	

## NUMBER 4/5

Articles		
R. Pallabazzer and A. A. Gabow	353	Wind generator potentiality in Somalia
C. Choudhury and H. P. Garg	363	Transient response of the Thomason type solar residential heating system
R. S. Mishra	371	Theoretical and experimental studies of pressurized and non-pressurized solar water heating systems of thermosyphonic type
L. O. Adekoya	385	Wind energy end-use: the performance characteristics of a rotating suction cowl
R. B. S. Chowdhury and D. J. Fulford	391	Batch and semi-continuous anaerobic digestion systems
K. K. Gopinathan and A. Soler	401	A sunshine dependent global insolation model for latitudes between $60^{\circ}N$ and $70^{\circ}N$
N. A. Rahim and E. Taqi	405	Comparison of free and forced condensing systems in solar desalination units
S. M. Nasir, S. M. Raza and I. A. Raja	411	Distribution of wind power resource over Pakistan
N. M. Nahar	421	Performance studies of a large size nontracking solar cooker
A. Hammache and E. Bilgen	431	Exergy and engineering analyses of hybrid thermochemical solar hydrogen production

J. F. Manwell, W. A. Stein, A. Rogers and J. G. McGowan

563

#### Contents

**		
I. L. Kolbenev	445	Expansion of fuel and power resources by the use of non-conventional power sources
Data Bank M. Al-Riahi, N. Al-Hamdani and K. Tahir	451	An empirical method for estimation of hourly diffuse fraction of global radiation
K. Vaníček	457	The estimation of solar radiation data in Czechoslovakia
F. J. K. Ideriah	461	On the characteristic distribution of hourly diffuse and global solar radiation at Ibadan
S. Coppolino	469	Applicability of a simple model for computing diffuse solar radiation to locations of the European, African, Asian and North American areas
El H. Aroudam, M. El Hammouti and H. Ezbakhe	473	Determination of correlations of solar radiation measured in Tetouan
Technical Notes C. A. Estrada-Gasca, G. Alvarez-Garcia, R. E. Cabanillas and P. K. Nair	477	Theoretical analysis of the thermal performance of all-glass evacuated tube solar collectors with absorber coating on the outside or inside of the inner tube
A. A. Ghoneim	485	Analysis of the performance of direct gain systems in Alexandria, Egypt
E. Barrera	489	A technical and economical analysis of a solar water still in Mexico
A. Zaouk, A. Rudra, P. Basmaji, J. F. Carlin and P. Gibart	497	18.5% AM1.5 efficiency GaAs solar cell grown by metal organic vapor phase epitaxy: a first step to realize III-V multi-junction cells
L. D'Alessio, M. Paolucci and G. De Maria	501	Design of solar receivers for chemical energy storage and pyrohelio- metallurgy applications
1. Chand and P. K. Bhargava	507	Studies on the effect of mean wind speed profile on the height of air layer affected by buildings
E. Scerri	513	Performance analysis between thermopile and silicon solarimeters
R. Verma, R. Chandra and H. P. Garg	521	Optimization of solar air heaters of different designs
M. Nurul Islam, B. S. Negi and T. C. Kandpal	533	Thermal performance of a Linear Fresnel reflector solar concentrator using a black liquid
Press Release	537	
WREN	539	
		NUMBER 6
Articles J. H. R. Enslin	543	Maximum Power Point Tracking: a cost saving necessity in solar energy systems
J. H. R. Enslin and J. D. Van Wyk	551	A study of a wind power converter with micro-computer based maximal power control utilising an over-synchronous electronic Scherbius cascade

An investigation of variable speed operation of diesel generators in hybrid energy systems

Contents

A. Mihelić-Bogdanić and R. Budin	573	Specific wind energy as a function of mean speed
V. K. Sharma, A. Colangelo and G. Spagna	577	Investigation of an indirect type multi-shelf solar fruit and vegetable dryer
S. A. M. Said	587	Application of photovoltaic systems in Saudi Arabia
W. B. Lawrance and R. Troster	591	Dynamic simulation of a solar pumping system
A. H. Algifri, S. M. Bin Gadhi and B. T. Nijaguna	597	Thermal behaviour of adobe and concrete houses in Yemen
D. M. Ghamari and R. A. Worth	603	The effect of tube spacing on the cost-effectiveness of a flat-plate solar collector
Data Bank		
V. T. Morgan	607	Statistical distributions of diffuse, beam and global solar irradiances in Sydney, Australia
M. Callegari, R. Festa and C. F. Ratto	611	Stochastic modelling of daily beam irradiation
Technical Notes		
A. Fasulo and L. A. Odicino	625	An inexpensive instrument to measure the absorptance of the solar radiation
A. N. Minasian and A. A. Al-Karaghou	li 631	Floating vertical solar still for desalination of marsh water
A. Hasan	637	Wind energy in West Bank and Gaza Strip
M. Martínez	641	Air pollutants due to energy supply in Mexico
F. Pelanchon, S. Mouhammad and P. Mialhe	645	A new optimized Si-solar cell structure